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ABSTRACT

Arguing that rapid developments in technology and changing enrollment patterns make updating the skills of two-year college mathematics faculty an imperative, this paper discusses the ways in which the continuing education needs of faculty members can be met. First, technological developments, especially in the computer sciences, are reviewed, and retraining needs are examined in the areas of content, curriculum, methodology, and attitudes, including the need for math faculty to develop an awareness of computing and the mathematical implications of computers and the need for improving the quality and usefulness of the math curriculum. After arguing that the retraining of current mathematics staff is feasible, the paper suggests that commitment on the part of planners and faculty be the underlying theme for all continuing education endeavors. Next, some traditional continuing education formats, such as release time, sabbatical leaves, and tuition reimbursements, are discussed as possible guides in formulating plans for the future. Then, a series of recommendations for continuing education programs are presented including: (1) expansion of government funding for teacher training programs; (2) faculty training efforts by professional mathematics societies; (3) support from business and industry for math faculty through in-plant training programs, research funding, and faculty employment during vacations; and (4) active and coordinated efforts by colleges and faculty to develop new skills. Finally, some consequences of lack of action are projected. (HB)

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CURRENT CONTINUING EDUCATION NEEDS OF TWO-YEAR COLLEGE MATHEMATICS FACULTY MUST BE MET!

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SUMMARY

CURRENT CONTINUING EDUCATION NEEDS OF TWO-YEAR COLLEGE MATHEMATICS FACULTY MUST BE MET!

Rapid developments in technology and changing student enrollment patterns make updating of two-year college mathematics faculty (TYCMF) skills imperative.

Furthermore, retraining of the current staff is feasible. Since approximately one-half of the faculty is under 45 and can expect to teach for at least another twenty years, efforts expended to update current faculty can have long-term benefits to the institutions involved. A substantial portion of TYCMF attempt to update their skills themselves by enrollments in graduate courses and attendance at conferences.

In the past, faculty have preferred short, intensive courses, sabbatical year formats or summer session programs. Current formal advanced degree programs do not fill the need for TYCMF renewal.

Continuing education needs of TYCMF should be met through expansion of government funding, endeavors by professional mathematical societies, industry and business support, and college and faculty action.

The consequences of lack of action in TYCMF continuing education are grim. There will be further inroads into two-year college programs, such as has occurred in remedial mathematics since four-year colleges started offering such courses. It is more efficient and less expensive to retrain and update TYCMF than to create or utilize other institutions whose design might, in the long run, be less effective than the two-year college has been.

CURRENT CONTINUING EDUCATION NEEDS OF TWO-YEAR COLLEGE MATHEMATICS FACULTY MUST BE MET!

I. RAPID DEVELOPMENTS IN TECHNOLOGY MAKE UPDATING OF TWO-YEAR COLLEGE MATHEMATICS FACULTY SKILLS IMPERATIVE.

A crucial need for continuing education of two-year college mathematics faculty (TYCMF) is not hard to show. In fact, instituting methods of renewal for K-12 math teachers was a key recommendation of the report, Educating Americans for the 21st Century, by a National Science Board Commission of the National Science Foundation (NSF). The need for updating TYCMF is just as great and can be found in at least four areas---content, curriculum, methodology and attitude.

As a result primarily of the rapid developments in technology, notably computers, both content taught at the two-year college in mathematics and approaches to teaching mathematics should undergo considerable change. Many TYCMF do not have skills to handle such approaches and courses.

As indicated in the 1983 report, "New Goals for Mathematical Sciences Education", by the Conference Board of Mathematical Sciences (CBMS), "The challenges and opportunities arising from computer science will have a significant impact on mathematical sciences education....The content of traditional courses such as linear algebra and calculus will be affected by computing. Computers will make several new mathematical science courses such as discrete mathematics and mathematical modeling of great importance, and new faculty will routinely use computing in their research and teaching. Thus, it is critical for efforts in renewal of collegiate mathematical sciences faculty to develop awareness of computers and the mathematical

methods they imply." The report further states, "Collegiate faculty will also need programs to increase their knowledge of...problem-solving of the ill-posed, real-world sort,...the mathematics of technology studies, and the many new examples of applications relevant to service courses in areas just beginning to use mathematics as an important tool."

In a study funded by NSF and the Rocky Mountain Mathematics Consortium, "An Inquiry Into the Graduate Training Needs of Two-Year College Teachers of Mathematics," the statement is made that the current situation in two-year colleges points to the "...clear need for a regular and sustained program of continuing education for two-year college mathematics faculty."

The biggest deterrent to providing mathematically competent citizens in our country is the lack of qualified mathematics teachers. Perhaps even the common defense and general welfare of our country is threatened by this situation (Willoughby, 1983).

A 1981 CBMS survey of undergraduate mathematics indicates that in two-year occupational/technical programs, the number of students now exceeds college transfer enrollments. Since 1975, computer course enrollments have exploded and now outnumber those in calculus. "Building on a small base in 1975, computing courses jumped by 850%!" (McKelvey, 1979). Access to computers is up sharply, but the use of computers in mathematics teaching has increased little since 1975. The growth in remedial course enrollments has slowed, but still amounts to 42% of two-year college mathematical science enrollments.

Further, William C. Missimer, Jr., Executive Vice-President, Pratt & Whitney Group, United Technologies Corporation, states that, "Within three

years, there will be a 31 percent increase in demand for technical graduates." He further states, "Colleges are finding it difficult to meet industry's demands for engineers because many of the schools don't have sufficient faculty....In computer science, where there is a burgeoning need, 16 percent of the faculty positions are going begging."

As a result of this new content, growing out of the rapid development of modern technology and changing patterns of student enrollment, there is a vast need for curricular change. As stated in "New Goals for Mathematical Sciences Education," the CBMS report, "The fundamentals of mathematics desirable for students at...college levels have, in the view of many mathematics educators, changed radically, yet the changes are not reflected in core curricula." As further evidence of the need for curricular reform, the National Science Board report, Educating Americans For the 21st Century, recommends "...improving the quality and usefulness of the curriculum." When changing the curriculum, the Commission recommended that there be a focus on all students, not just pre-professionals in science and mathematics. While this recommendation applies specifically to K-12 mathematics, the two-year college currently teaches all of grades 9-12 mathematics. Changes such as are recommended by this commission must therefore be reflected in the two-year college curriculum as well. Faculty need to be informed regarding what curricular changes are needed and how to implement them.

Better methodology in teaching is a third way in which TYCMF need updating. In a recent survey, teachers indicated that their biggest problems were teaching unmotivated students, having to cover much more

material than students can absorb, and coping with the deluge of remedial mathematics (McKelvey, 1979).

Finally any comprehensive continuing education program must incorporate a consideration of the teaching climate and the attitudes of the TYCMF. Performance of teachers is a function of ability, motivation and climate. Little has been done in staff development beyond ability (Hammonds, 1982).

Traditionally the administration has found it easier to employ new instructors to perform new or different functions than to retrain old instructors. This approach worked as long as the expansion of the two-year college was rapid. Now, with the slackening of growth, there is a need for staff development (Cohen, 1982).

II. RETRAINING OF CURRENT STAFF IS FEASIBLE

Such retraining and development of TYCMF is feasible. Since approximately one-half of the faculty is under 45 and can expect to teach for at least another 20 years, efforts expended to retrain and update current faculty can have long-term benefits to the institutions involved. As employment of part-time faculty continues to sky-rocket, hiring of newly trained, young faculty in full-time positions seems unlikely.

In 1980, 59% of the faculty reported attendance at one or more mathematics conferences per year, while 22% said they were taking additional graduate courses that year (Fey, 1981). So the desire and the ability to learn is certainly there (McKelvey, 1979).

III. COMMITMENT SHOULD BE THE UNDERLYING THEME FOR ALL CONTINUING EDUCATION ENDEAVORS.

If the needs for updating TYCMF are to be met, a variety of approaches must be diligently pursued, and the underlying theme of all such endeavors must be commitment and cooperation on both the part of the planners and the faculty. In "New Goals for Mathematical Sciences Education," CBMS speaks of "...the need for a continuing commitment from all parties participating in renewal programs...."

The administration of the colleges must exhibit an interest in what is most important to the faculty---the learning of their students. Research indicates that almost every factor influencing individual development, productivity, and creativity is fostered by management (Duncan, 1982).

Stephen S. Willoughby, President, National Council of Teachers of Mathematics (NCTM), stated in January of 1983 that if a true national commitment were to be made to education, then several important actions should be taken. Notably he recommended providing "...more opportunity and incentive for teachers to continue their professional development through participation in activities of professional societies and through further formal education." He further recommended standards for becoming and remaining a teacher be improved and that the salary of every teacher in the country be doubled. While this last recommendation seems drastic, the recent Carnegie Foundation report noted that teachers are now among the nation's lowest paid professionals, averaging $20,500 per year in salary. Many jobs in industry that do not require a college education pay more than that (Missimer, 1984).

IV. TRADITIONAL CONTINUING EDUCATION FORMATS.

Lessons learned in the past can be a guide in formulating plans for the future. Traditionally, faculty development has taken the form of discipline-based institutes, release time, sabbatical leaves and tuition reimbursements for instructors to attend university-based programs. There have also been short courses or workshops on pedagogy sponsored by single institutions or by institutional consortia. The instructors have preferred courses and programs in their teaching field, offered by universities close at hand, that enabled them to gain further knowledge in their field and to rise on the salary scale (Cohen, 1982).

The most popular formats have been short, intensive courses of three to five days duration, sabbatical year formats, and summer session programs (McKelvey, 1979). An apparent concern, reflected in all these preferences, is the need to protect the faculty member's income while at the same time updating skills. This need must be considered in plans to update skills so that the faculty is freed from the worry of financial loss during retraining.

While participating in a formal degree program can provide a focus and a systematic approach to continuing education, obtaining a standard doctorate is termed "unimportant" to a majority of TYCMF (McKelvey, 1979).

Current advanced degrees available (D.A., Ph.D., Ed.D) are not likely to meet the needs of TYCMF even though obtaining such a degree is one way to advance both professionally and monetarily. The most obvious reason for such an attitude on the part of a majority of the faculty is that such programs have neither the content nor the methodology needed in two-year

college mathematics instruction today. If formal degree programs are to have a place in the retraining of TYCMF, then vast reorganization of the content of those degrees must take place.

V. RECOMMENDATIONS FOR CONTINUING EDUCATION PROGRAMS.

A. EXPANSION OF GOVERNMENTAL FUNDING

Educating Americans For the 21st Century proposes solutions for the improvement of K-12 mathematics education. The report states, "Most of the nation's 200,000 secondary mathematics and science teachers... require additional training because of the rapid development of new knowledge in mathematics and science...." To help with the educational needs of current K-12 mathematics teachers, the Commission recommended that NSF establish state-wide or regional teacher training programs using the new information technologies such as telecourses and interactive telecommunications. In addition, it was recommended that the states develop teacher training and retraining programs with colleges, universities and museums. Further, the states should develop regional training and resource centers which would include computer instruction and software evaluation. These centers could serve as the focus for participation of business and government in education.

Other notable advocates of increased governmental funding of faculty retraining include CBMS, Stephen Willoughby, President of NCTM, and Amber Steinmetz, President of The American Mathematical Association of Two-Year Colleges (AMATYC).

Nearly all of the current funding from NSF, historically the prime source of governmental support for mathematics education, is either in the

area of K-12 or in mathematical research. These efforts are strongly supported. However, it is imperative to the health of the two-year college mathematics program that NSF recognize the importance of the two-year college in the educational network of America today. New programs should be instituted to retrain the current TYCMF or access to existing and future programs for K-12 teachers should be strongly encouraged. The National Center for Education Statistics reports that the proportion of students in post-secondary education attending two-year colleges rose from 26% in 1970 to almost 40% in 1982! Yet there are few, if any, programs directed toward the benefit of the two-year college and none in faculty retraining or renewal!

There are strategies that have proven effective in the past that should be revived and supported. The Chautauqua Short Courses and various stipends for summer institutes and academic year study are prime examples (CBMS, 1983). The NSF institutes of the last two decades were successful programs which retrained many teachers in the current skills of the day. More than half of today's TYCMF previously taught in secondary schools and received additional training in those NSF institutes.

B. ENDEAVORS BY PROFESSIONAL MATHEMATICS SOCIETIES.

Faculty retraining is currently being undertaken by the various professional mathematics societies, such as AMATYC, The Mathematical Association of America (MAA), and NCTM.

MAA presents minicourses at its conventions. These minicourses are in many of the areas that have been discussed---such as discrete mathematics and computer technology. AMATYC has been presenting work-

shops for several years which are held the day before its regular national convention. Topics in which faculty currently need instruction have been prominent, such as computers and applications of mathematics. AMATYC is planning a summer workshop in 1985 to provide TYCMF continuing education carrying graduate credit in discrete mathematics and computer technology. Faculty appear eager to learn. MAA had waiting lists for all its minicourses from 30 to 60 persons at its January, 1984, convention. Many interested faculty were turned away due to lack of space and the overwhelming demand.

CBMS recommends that "...the professional societies in the mathematical sciences, especially NCTM, MAA, and AMATYC, seek support for projects to demonstrate effective models of the various faculty renewal activities...." Further, Educating Americans For the 21st Century recommends that "the professional societies in mathematics should play an active role in curriculum development, review and revision."

These activities by professional societies are commendable but are only a beginning. Continuing education by professional societies is "high value at low cost." (Moneysmith, 1984). However, funding is needed to expand the scope and availability of such endeavors. This additional support should be given by the federal government, perhaps through NSF.

C. INDUSTRY AND BUSINESS SUPPORT.

An exciting and promising source of support for TYCMF development is business and industry. The call for active and aggressive participation from this source is rapidly increasing. Such participation is appropriate and necessary as business and industry are prime recipients of the benefits of quality education. Since faculty skills are rusty and have not kept

pace with technological developments, it is necessary in the face of the tremendous need and lack of sufficient resources elsewhere that business and industry assume a major role in the retraining of TYCMF.

As William C. Missimer, Jr. has stated, "Business and industry...must become a focal point to bring about needed improvements in the scientific and technological literacy of our youth....Everything that might go into an attack on the problem must include a high-priority goal: the restoration of competent, fully-certified math and science staffs throughout all levels of our educational system."

He specifically recommends that business and industry should:

*Help teachers relate classwork to the workplace by hiring them during the school vacations.

*Invite teachers to attend in-plant training programs so they can see how math skills are being applied.

*Send more of their employees to visit schools and discuss the need for mathematics.

*Fund research centers on campuses where faculty, industry and students could study new technologies.

*Provide quality programs of financial support and academic encouragement to help ease the loss of mathematics faculty.

*Donate surplus high-technology equipment to schools.

*Work with teachers to revise curricula so that there is a proper emphasis and balance in the changes.

The idea of industry hiring faculty during vacations has been advocated by others. Stephen Willoughby has said industry should be encouraged "...to hire mathematics and science teachers during the summer to enhance their incomes and their knowledge of how their subjects are used in industry."

The concept of industry and business participation in faculty continuing education is carried a bit further in a model proposed by Richard Afred and Nancy Nash in a recent Community College Review article. They recognize that there is a difficulty in encouraging faculty to update teaching skills if course content or methodology must change. To remedy this difficulty, they proposed that faculty be placed in business and industry settings for six to twelve months to "...learn new skills, validate theory, study current practices, and learn problem-solving techniques." Simultaneously, industry professionals and technicians could be placed in the two-year colleges to teach the load of the staff placed in the industrial or business setting and to evaluate and modify occupational curricula to comply with the changing technology. The benefits of this plan would be the modernization of the college curricula in accordance with emerging technology while simultaneously preparing the faculty member to return to an academic setting to teach the new curricula.

Participation of business and industry in faculty development is important also because TYCMF perceive their background as being least adequate in the areas of application (McKelvey, 1979). Furthermore, the plan is made more feasible by the fact that most two-year colleges already have contacts with business and industry through liaison personnel for the occupational, apprenticeship and technical programs. Added stimulus for this concept could be given by local, state, and federal governments in the form of tax credits and like incentives.

With business and industry contributing to the retraining of TYCMF, all parties involved win. The faculty member becomes acquainted with the

latest technology, is revitalized and gains professional enrichments. Students benefit from an improved curriculum and a more knowledgeable teacher. The college benefits from an updated program. Industry benefits from a better trained pool of employees (Conrad, 1982). Given the substantial benefits that business and industry would reap, it is appropriate that they contribute financially to TYCMF continuing education.

D. COLLEGE AND FACULTY ACTION.

Finally, the two-year college itself must recognize the very real and urgent need for development of its mathematics faculty, as well as the fact that the quality of its faculty is ultimately its own responsibility. An active, coordinated effort should be instituted at once by the two-year colleges across the nation to implement the various plans proposed for faculty retraining. The help and support of the faculty, professional mathematical societies, business and industry must be solicited actively. Local, state, and federal grants must be encouraged to recognize the place of two-year colleges in the mathematics and science education of our student population. The various programs already available and which are currently being instituted to retrain K-12 mathemaics teachers must be expanded to include TYCMF.

If efforts to expand the base of support are unsuccessful, then the two-year colleges must be prepared to extend their own resources and programs for continuing education for TYCMF. More monies should be provided and more sabbaticals should be awarded in the area of mathematics and computer science to retrain faculty. If the two-year colleges want to remain intact as the type of training institutions they are, then they

must make a firm commitment to retraining their mathematics faculty in the modern methods and content.

The individual in many professions is responsible for keeping his or her own skills current. In these professions the consequences of inadequate skills may be lack of advancement or, in extreme cases, loss of employment. Many TYCMF have grown lazy as a result of employment protection provisions of contracts and tenure laws. Such job security is certainly good to have, but this apathy is contributing to many TYCMF rapidly having obsolete skills. To remain a professional, it is necessary for TYCMF to actively pursue updating of their skills as well as being the recipients of support and actions on the part of others.

Particularly in the area of computer training, some TYCMF have resisted learning new skills. The reasons for such avoidance include a fearing requirement to teach computer science rather than mathematics, lacking either the time or financial resources to train in these areas, or resisting the infusion of computer science into the mathematics curriculum. The time is past when mathematicians can be ignorant about computers. Just as resistance to classroom use of hand-held calculators a few years ago is largely a thing of the past, now computers should be regarded as affecting almost all aspects of our lives. For mathematics teachers to remain ignorant regarding computers is to become incompetent.

VI. CONSEQUENES OF LACK OF ACTION.

The results of continued apathy or lack of diligence in finding a solution to this problem are grim indeed. Declining college enrollments and changing student bodies at four-year colleges and universities have

resulted in expansions of programs into areas regarded until recently as the domain of the two-year college. For example, until about three years ago, post-secondary remedial mathematics was taught almost entirely by two-year colleges. Increasingly today, four-year colleges and universities are adding remedial mathematics courses to their curriculum.

Unless the two-year college actively assumes a greater role in seeing that its technical and scientific staff are properly retrained, more erosion of current programs will occur. In addition, the two-year college will be unable to offer a modern course of study needed as a result of our changing technology. If the demands of business and industry for modern programs cannot be met appropriately by the two-year college, then other institutions will be called upon to meet the need. Perhaps the four-year colleges will step into that place, or industry and business themselves will establish their own training programs. The two-year colleges have been in place and functioning across the nation for half a century. Presumedly, it is more efficient and less expensive to retrain and update TYCMF than to create or utilize other institutions whose design might, in the long run, be less effective than the two-year college has been and can be.

One thing is certain. Without modern teaching techniques and competent faculty in mathematics and science, the two-year college will be left behind in a high-tech society.

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